

THE 1998 CLIMATE-INDUCED BLEACHING OF GREAT BARRIER REEF CORAL REEFS

**An International Collaborative Project
between
The United States National Oceanic and Atmospheric
Administration**

The Australian Institute of Marine Science

And

The Great Barrier Reef Marine Park Authority

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INTRODUCTION

During 1998, reports of coral bleaching reached unprecedented levels and coral reefs throughout the world experienced bleaching which has varied from mild to severe in intensity.

On the Great Barrier Reef, Australia, from February to April 1998, a widespread coral bleaching event occurred which appears to be the most severe and extensive episode on record. Early reports suggest that the bleaching was followed by extremely high mortality in at least some areas. This is an event of major ecological significance within the context of at least the last two decades, and possibly much longer time scales. While temperature appears to be the predominant causal factor in almost all these bleaching events, correlations with regional and global climate patterns, and global climatic trends are not certain. Work carried out by NOAA has suggested that anomalous "hotspots" in satellite derived temperature data may serve to explain and perhaps even anticipate bleaching episodes.

Corals, normally tan in color, turn pale or pure white as the corals expel the thousands of microscopic algae that normally live within their tissues. These algae provide their coral host with oxygen and vital nutritional matter, thus supporting growth, reproduction and accumulation of limestone skeletons. For individual corals, which range in size from a few centimeters to several meters, the range of consequences include:

- What proportion of the currently bleached coral will go on to die?
- How will this affect the structure and functioning of the reef ecosystem?
- What were the proximate (e.g. local climatic) factors responsible for the onset of the bleaching? Were they spatially uniform over the entire GBR?
- What roles do global climatic patterns and trends play as possible ultimate causal agents?
- Is there any evidence that the frequency and/or severity of bleaching events and associated climatic anomalies is increasing?

We need quantitative data on the impact, and we need better understanding of organism environment interactions if we are to answer such questions.

It has been agreed that a collaborative international project to investigate the GBR bleaching episode be established. The project would enable the predictive and explanatory procedures established by NOAA to be tested and refined in a region where there is an exceptionally good record of coral bleaching, in situ measurements, and established skills in biological assessment, remote sensing and climate analysis.

Specifically, the three organizations in this proposal have complementary skills and facilities which could be combined to investigate the possible relationship between bleaching and climatic variations at different geographic and time scales.

Institutional Strengths relevant to project:

GBRMPA

- Bleaching records for the GBR (1979-1998)
- Detailed in situ temperature data (non real-time)
- Expertise on thermal tolerance and acclimation ability of corals

AIMS

- Real time weather data (weather stations)
- Archived NOAA satellite data for the GBR at Local Area Coverage (LAC) scale
- Time series analysis expertise
- Reef Assessment expertise and LTMP data
- Radiometer data for ground verifying satellite data

NOAA

- Hotspot analysis skills
- Basic satellite data processing expertise
- Expert system expertise for real time warnings of potential bleaching
- Facilities to establish centralized server for all data

The following major outputs are proposed for this project.

1. Bleaching hotspot analysis based on NOAA LAC data
2. Comparison of these high resolution hotspots with detailed GBR bleaching records
3. Hind-casting of bleaching on the GBR based on proven abilities of hotspot analysis in this area
4. Time series and correlative analysis of meteorological and COADS and AUSCORE data in relation to bleaching records, global climate change and ENSO events
5. Real time alerts of conditions conducive to bleaching for selected sites on the GBR
6. A determination of the feasibility/usefulness of turbidity (ocean color) wind, salinity and insolation data in enhancing the prediction of bleaching hotspots

It is proposed that the project commence in 1999 and continue for 2 years initially. The following tasks have been identified.

Institutional contributions

Starting dates: (J99)=July 1999; (D99)=December 1999; (J00)=January 2000

GBRMPA

- (J99) Secondment of Ray Berkelmans to AIMS to
 - Work up bleaching data
 - Assist in correlation analysis with satellite and temperature data
 - Manage/revamp of AIMS weather stations
- (J99) Partially fund revamp of weather stations

AIMS

- (J99) Will Skirving to supervise analysis of GBR LAC data in collaboration with NOAA scientists and investigate possible revised algorithm using radiometer data
- (J99) Janice Lough to correlate in situ temperature (and salinity?) and satellite data to ship/buoy data
- (D99) Partially fund revamp of weather stations
- (J00) Will Skirving to investigate SEAWIFS data for correlations between bleaching and turbidity

NOAA

- (J99) Assist in analysis of GBR LAC data using NOAA algorithm
- (D99) Assist in development of a potential revised algorithm for tropics
- (D99) Calculate high resolution hotspots (using GBR LAC)
- (J99) Develop/refine expert system to predict bleaching at selected GBR sites
- (J99) Provide and maintain a server for all data
- (J00) Work with Skirving and Berkelmans on possible correlations with ocean color and salinity data

Still to add:

General approach:

- each institution to contribute with its own funds and personnel in their own labs;
- use email, data servers etc to create a "virtual lab";
- organize face to face meetings at least once per year (preferably twice -- first could be in Hawaii after the remote sensing meeting)

Detailed summary for each output with budget and timelines personnel etc An overall summary outlining any final products such as a book or a series of papers and popular articles